3:40-5:20 Posters

Lecture sessions will recess for presentation of poster papers on various topics in acoustics. See poster sessions for topics and abstracts.

Contributed Paper

5:20

2pEAa6. Thin film thermo-viscous damping in miniature condenser microphones. Thierry Le Van Suu (Laboratoire d'Acoustique de l'Université du Maine, Avenue Olivier Messiaen, 72085 Le Mans, France, thierry.levansuu@univ-lemans.fr), Petr Honzik (CVUT v Praze, Fakulta Elektrotechnická, K13137 Katedra Radioelektroniky - Technická 2, 166 27 Praha 6, Czech Republic, Petr.Honzik@lf1.cuni.cz), Stephane Durand (Laboratoire d'Acoustique de l'Université du Maine, Avenue Olivier Messiaen, 72085 Le Mans, France, stephane.durand@univ-lemans.fr), Nicolas Joly (Laboratoire d'Acoustique de l'Université du Maine, Avenue Olivier Messiaen, 72085 Le Mans, France, nicolas.joly@univ-lemans.fr), Zdeněk Škvor (CVUT v Praze, Fakulta Elektrotechnická, K13137 Katedra Radioelektroniky - Technická 2, 166 27 Praha 6, Czech Republic, skvorzdn@feld.cvut.cz), Michel Bruneau (Laboratoire d'Acoustique de l'Université du Maine, Avenue Olivier Messiaen, 72085 Le Mans, France, michel.bruneau@univ-lemans.fr)

The thermo-viscous damping due to the thin fluid film between the membrane and the backing electrode strongly influences both the sensitivity of the condenser microphones in the lower frequency range and the upper limit of the frequency bandwidth. Nowadays, most of the MEMs microphones use a perforated backing electrode while some authors suggest that a continuously curved backing electrode could enhance their performances (among avantages in the design when etching). The present paper provides two kinds of modeling for such microphones with a tapered fluid film: the first one lies on Kirchhoff-network analysis (neglecting cross-coupling between elements) whereas the second one is based upon the direct resolution of the set of basic equations (including heat transfer phenomena). The results are presented and discussed for both models in the cases of flat, parabolic, and stepped shapes backing electrode. Finally, the pressure field in the fluid film, computed (for an axisymmetrical configuration) using the above-mentioned models, is compared to the one computed with a new FEM formulation taking into account both viscous and thermal phenomena in the boundary layers.

Invited Paper

5:40

2pEAa7. Miniature diffraction-based optical MEMS microphones with integrated optoelectronics. Levent Degertekin (Georgia Institute of Technology, G. W. Woodruff School of Mechanical Engineering, 801 Ferst Dr. NW, Atlanta, GA 30332-0405, USA, levent@gatech.edu), Kamran Jeelani (Georgia Institute of Technology, G. W. Woodruff School of Mechanical Engineering, 801 Ferst Dr. NW, Atlanta, GA 30332-0405, USA, gtg804t@mail.gatech.edu), Shakeel Qureshi (Georgia Institute of Technology, G. W. Woodruff School of Mechanical Engineering, 801 Ferst Dr. NW, Atlanta, GA 30332-0405, USA, shakeel@ece.gatech.edu), Paul Hasler (Georgia Institute of Technology, School of Electrical and Cumputer Engineering, 777 Atlantic Drive NW, Atlanta, GA 30332-0250, USA, phasler@ece.gatech.edu), Baris Bicen (Georgia Institute of Technology, G. W. Woodruff School of Mechanical Engineering, 801 Ferst Dr. NW, Atlanta, GA 30332-0405, USA, baris@gatech.edu), Weili Cui (State University of New York, PO 6000, Vestal Parkway East, Binghamton, NY 13902-6000, USA, weilicui@yahoo.com), Quang T. Su (State University of New York, PO 6000, Vestal Parkway East, Binghamton, NY 13902-6000, USA, be83190@binghamton.edu), Ronald N. Miles (State University of New York, PO 6000, Vestal Parkway East, Binghamton, NY 13902-6000, USA, miles@binghamton.edu)

Diffraction-based optical interferometric sensing has been shown to be a low-noise displacement detection method for MEMS microphones. For this method to be useful in many important applications such as hearing aids, it needs to be packaged in a small volume and should have power consumption levels suitable for operation with a battery. In this talk, we describe miniature, packaged optical microphones that use solid state vertical cavity surface emitting lasers (VCSELs) as light sources and custom designed photodetectors. The package carries silicon chips with two micromachined biomimetic differential microphones as well as an omnidirectional microphone. It is made by 3-D laser stereo lithography process and has dimensions suitable for behind-the-ear hearing aids. With this configuration, the input referred noise floor for the differential microphone is measured as 42.6dBA, limited by the VCSEL intensity noise in this particular case. In addition to miniature packaging, an optoelectronic chip including VCSEL pulser, photodetectors, transimpedance amplifiers and 1 bit Sigma-Delta ADC has been implemented in 1.5V, 0.35u CMOS technology. The second order ADC structure providing 14-bits of theoretical resolution with 64 over sampling ratio and 20 kHz input signal is described and initial characterization results are presented.

Contributed Papers

6:00

2pEAa8. On determination of microphone response and other parameters by a hybrid experimental and numerical method. Salvador Barrera-Figueroa (Danish Fundamental Metrology, Matematiktorvet 307, 2800 Kgs. Lyngby, Denmark, sbf@dfm.dtu.dk), Finn Jacobsen (Acoustic Technology Department, Technical University of Denmark, Ørsted Plads, B352, DK-2800 Lyngby, Denmark, fja@oersted.dtu.dk), Knud Rasmussen (Danish Fundamental Metrology, Matematiktorvet 307, 2800 Kgs. Lyngby, Denmark, kra@dfm.dtu.dk)

Typically, numerical calculations of the pressure, free-field and random-incidence response of a condenser microphone are carried out on the basis of an assumed displacement distribution of the diaphragm of the microphone; the conventional assumption is that the displacement follows a Bessel function. This assumption is probably valid at frequencies below the resonance frequency. However, at higher frequencies the movement of the membrane is heavily coupled with the damping of the air film between membrane and back plate, and with resonances in the back chamber of the microphone. A solution to this problem is to measure the velocity distribution of the membrane by means of a non-contact method, such as laser vibrometry. The measured velocity distributions can be used together with a numerical formulation such as the Boundary Element Method for estimating the microphone response and other parameters such as the acoustic centres. In this work, a hybrid method is presented. The velocity distributions of condenser Laboratory Standard microphones were measured using a laser vibrometer. This measured velocity distribution was used for estimating the microphone responses and parameters. The agreement with experimental data is good. This method can be used as an alternative for validating the parameters of the microphones determined by classical calibration techniques.